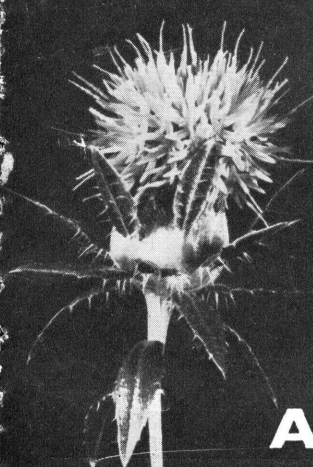
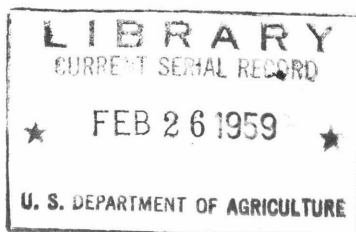
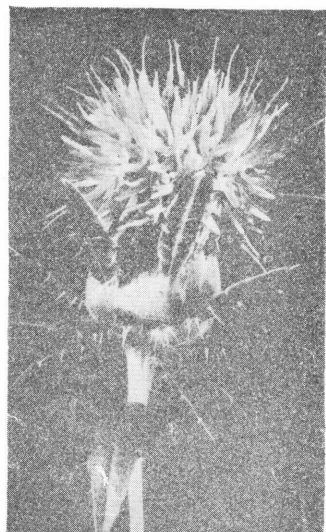
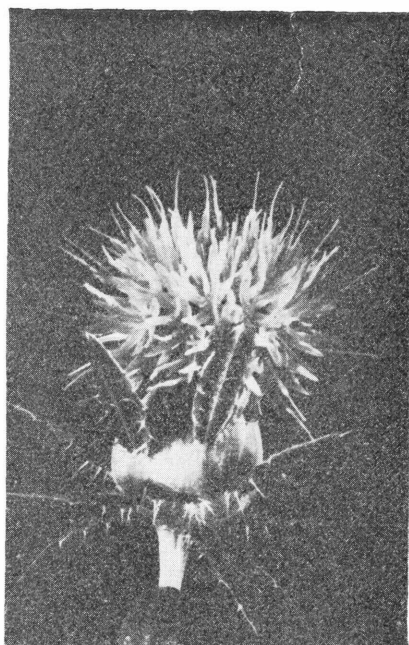


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**GROWING**  
**SAFFLOWER**  
**An Oilseed Crop**

Farmers' Bulletin No. 2133

UNITED STATES DEPARTMENT OF AGRICULTURE

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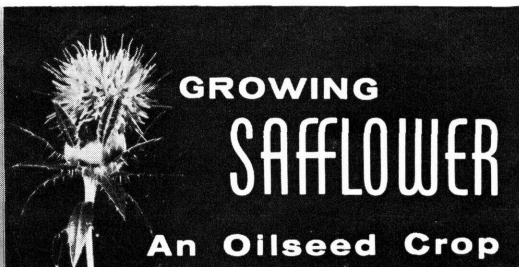
*Prepared by*

Crops Research Division

Agricultural Research Service

Washington, D. C.

Issued February 1959



Safflower<sup>1</sup> is an oilseed crop adapted to the wheat and barley areas of the western United States that have dry atmosphere in the latter part of the growing season.

The crop has been known for centuries in India, the Middle East, and North Africa, where it is the source of a dye and an edible oil. Safflower was introduced experimentally as an oil crop in the United States in 1925. American farmers began growing safflower about the end of World War II.

About 175,000 acres of safflower were planted in the United States in 1958.

In some varieties, the seed contains about 35 percent of oil. Such varieties are available for commercial production. Plant breeders are developing new varieties with increased oil content.

## USES

Safflower oil is light colored and easily clarified. It is used in paints and varnishes because it is non-yellowing. Processed oil may have some potential use as an edible vegetable oil for human diets.

Meal or seedcake made from safflower seed is a protein feed supplement for cattle, sheep, and

poultry. Meal from unhulled seed contains 18 to 24 percent of protein. Safflower meal from hulled seed contains 28 to 50 percent of protein.

Plants seldom are used for livestock feed. However, cattle will eat safflower plants without regard for the small spines that develop on the leaves, heads, and stalks.

## DESCRIPTION

Safflower is an annual of the thistle family. Commercial varieties grown in the United States are spiny. Present spineless varieties contain too little oil or do not yield well.

The plant has composite flower heads with green bracts. The most common varieties have yellow or orange flowers. Some varieties have red or white flowers. Each central stem usually produces 1 to 5 flower heads; each flower head contains 40 to 100 florets. At maturity, a floret bears one seed, which is about the size of a barley kernel.

Safflower develops sturdy taproots. It forms oblong, waxy leaves that may grow slowly in flat rosettes at ground level during periods of cool, short days. With warmer weather and longer days, the plant grows upright. Branching begins from the central stem

<sup>1</sup> *Carthamus tinctorius* L.



when the plant is 8 to 15 inches high. Safflower reaches its full height of 1½ to 5 feet when it flowers.

Safflower matures in 110 to 150 days as a spring-planted crop and in 200 or more days as a fall-planted crop.

Seed weighs 37 to 48 pounds per bushel; the weight depends on the variety and on growing conditions. The hull accounts for one-third to one-half of the total weight of the seed. The seed contains 26 to 37 percent of oil, 11 to 17 percent of protein, and 5 to 7 percent of moisture.

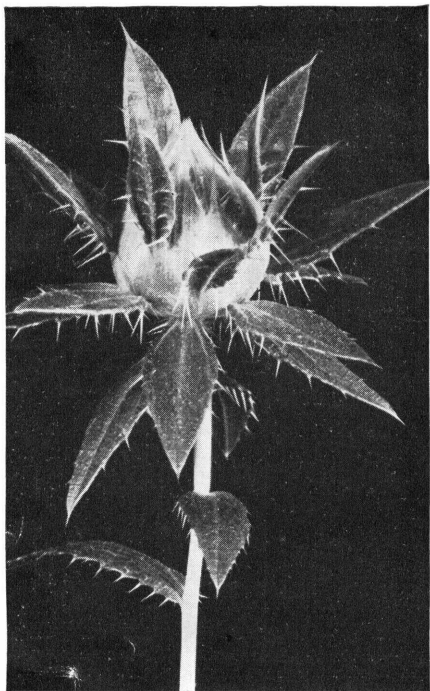
Safflower usually will not grow as a weed; competing wild plants will overshadow it before it becomes established.

## ADAPTATION

Safflower is adapted to parts of the northern Great Plains, the area between the Cascade and Rocky Mountains, the interior valleys of California, and irrigated sections of Arizona. At times, it has been grown successfully in parts of all States west of the 100th meridian. Production has been most successful in the Sacramento Valley of California.

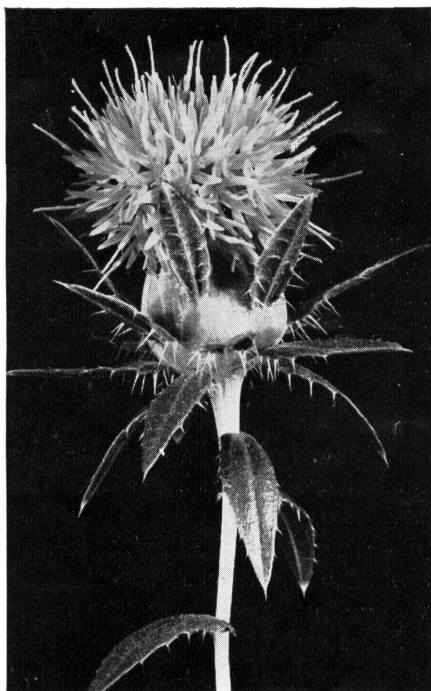
The crop is not adapted to the Corn Belt or to the eastern or southern States.

In some parts of the Great Plains and in California, safflower has been grown under irrigation. In California, most of the safflower is grown without irrigation, either



BN-6698

Flower head before opening.



BN-6698

Head in flower.

following an irrigated crop or on land with a high water table.

### Weather

Emerging plants need cool, short days for root growth and development of the rosette stage. Higher temperatures and longer days promote stem growth and flowerhead formation. Dry atmospheric conditions during and after flowering are necessary for proper seed set and high oil content.

Seedlings can withstand temperatures down to 20° F.; plants 4 to 5 inches tall tolerate temperatures down to 25°. Varieties differ greatly in tolerance to frost during early growth. Freezing temperatures may damage budding and flowering plants. Frost on an unripened crop may reduce the quality and yield of seed.

Safflower is more tolerant of wind and hail than are barley and small grains. Safflower stems may be damaged severely by hail while they are actively growing and succulent. After it matures, the plant does not lodge and the seed does not shatter easily.

### Moisture

Safflower may be grown under irrigation or as a dryland crop. It also may be grown following a wetland crop—such as rice—on high-water-table land without additional irrigation; this method is essentially subirrigation.

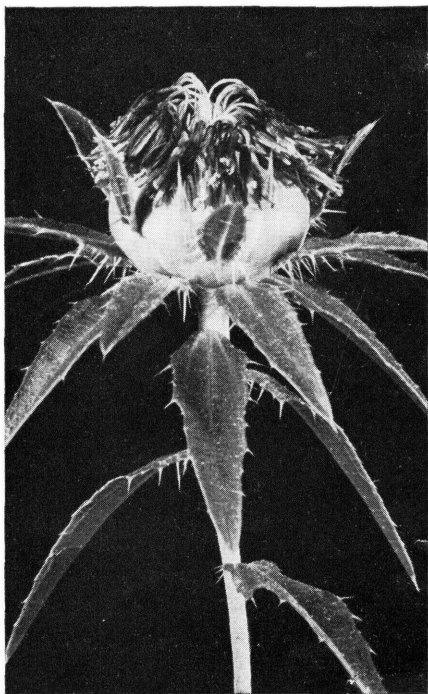
Safflower needs soil moisture from the time it is planted through flowering. If it does not have enough moisture during budding, safflower may not produce a satisfactory yield.

Rains or high humidity during ripening and harvesting may reduce seed yields.

For maximum yields, safflower needs soil moisture equal to 25 inches of rainfall a year. A satisfactory yield may be obtained in an alternate crop-fallow system in areas with soil moisture equal to 12 to 18 inches a year. On land with no moisture reserve, safflower needs about 12 inches of rain or equal irrigation during the growing season. Late winter rains are beneficial.

Safflower grown under total irrigation needs 3 to 3½ acre-feet of water.

Safflower grown under dryland conditions needs soil moisture to a depth of 4 feet at planting time.



BN-6698

Head after flowering.

## Soil

Plant safflower on well-drained land of average texture and fertility. Safflower thrives in deep sandy or clay loam soils with adequate drainage. When grown on land with poor water penetration, the plant is particularly vulnerable to disease.

Safflower needs soil that is neither too acid nor too alkaline. It has about the same tolerance to alkali as barley.

On irrigated light soils, safflower stubble remaining after harvest may reduce wind erosion.

## Place in Rotation

Safflower often replaces barley or other small grains in rotation. It matures too late to be used in double cropping.

On dry land, highest safflower yields follow summer fallow. On irrigated land, safflower can follow wheat, corn, potatoes, beets, rice, grasses, clover and other legumes, or small grains. Safflower should not follow itself in the rotation—particularly on irrigated land—because of disease hazards.

When planted following safflower, late crops—such as potatoes, beans, and corn—produce higher yields than they do following small grains.

## ECONOMIC FACTORS

Because safflower is a relatively new crop, the market is not fully developed. Usually the crop is grown and sold under contract. Some processors guarantee growers a fixed price per ton; others pay the market price at harvest. Often the processor supplies seed.

Before deciding to plant safflower for the first time, discuss selling the crop with an established contractor, processor, or experienced grower, or with your county agricultural agent.

## Cost of Growing

The cost of growing safflower may be compared with the cost of growing barley or wheat in the same area. In Arizona in 1956, safflower required two additional irrigations and cost about \$10 more per acre to produce than barley. In California, the costs of growing safflower and barley without irrigation were about equal.

Safflower is planted, cultivated, and harvested with the same machinery as small grains. Harvesting safflower is about as expensive as harvesting wheat; however, the combine operates at a slower rate.

## Price

Safflower oil sells for about the same price as linseed or soybean oil. Seed sells for about twice the price of barley.

## Yields

Poor yields may be caused by poor land, improper seedbed preparation, weeds, late planting, too early harvest, early frost, too much or too little water, diseases, and insects.

In California, safflower yields about 90 percent as much per acre as barley.

In 1956, average yield on 80,000 acres in California was 1,700 pounds of safflower seed per acre. Top yields of 4,800 pounds of seed per

acre were from irrigated and sub-irrigated land. In contrast, some dryland plantings in poor years produced yields of less than 300 pounds of seed per acre.

In the northern Great Plains, fallow land yields as much as 2,000 pounds of seed per acre under favorable dryland conditions. Average dryland yields are 700 to 1,200 pounds per acre.

## VARIETIES

Varieties differ in flower color, degree of spininess, diameter of seed heads, oil content, and resistance to disease.

Since 1946, many safflower varieties have been developed, introduced, and then replaced by superior varieties. A number of new varieties are being increased for future introduction. Consult your county agricultural agent or the State agricultural experiment station for latest information on recommended safflower varieties in your area.

In 1958, the most widely grown varieties were N-10 and Pacific 1.

N-10 is adapted to dryland and subirrigated production. It has yellow flowers, grows rapidly in early stages, and matures moderately early. It is susceptible to rust and root rot. N-10 contains 28 to 37 percent of oil.

Pacific 1, an improved variety similar to N-10, also is adapted to dryland and subirrigated production. It has orange flowers, grows rapidly in early stages, and matures early. It is resistant to one race of rust; it is susceptible to root rot. Pacific 1 contains 28 to 37 percent of oil.

Gila, a variety that has shown resistance to root rot in preliminary tests, was released in Arizona for seed increase and production in 1958. It is susceptible to prevalent rust races and is similar to N-10 in yield and oil content.

## SEED

Obtain safflower seed from a seed processor or wholesale seed distributor. Plant only seed that is clean and free of foreign matter, weed seeds, and small grains. Wheat, oats, and barley are particularly difficult to separate from safflower. Do not plant seed that contains more than a trace of these grains.

All seed should be treated with a fungicide before planting. Seed treatment helps control seed-borne rust and *Alternaria* and insures more uniform stands of vigorous plants. Most seed processors treat seed before selling it.

Use seed that has been treated with a volatile mercury fungicide, such as Ceresan 75<sup>2</sup> or Panogen 15,<sup>3 4</sup> at a dosage of 1 to 2 ounces per bushel. Other similar volatile mercury formulations may be used at dosages determined by concentration of active ingredients or at

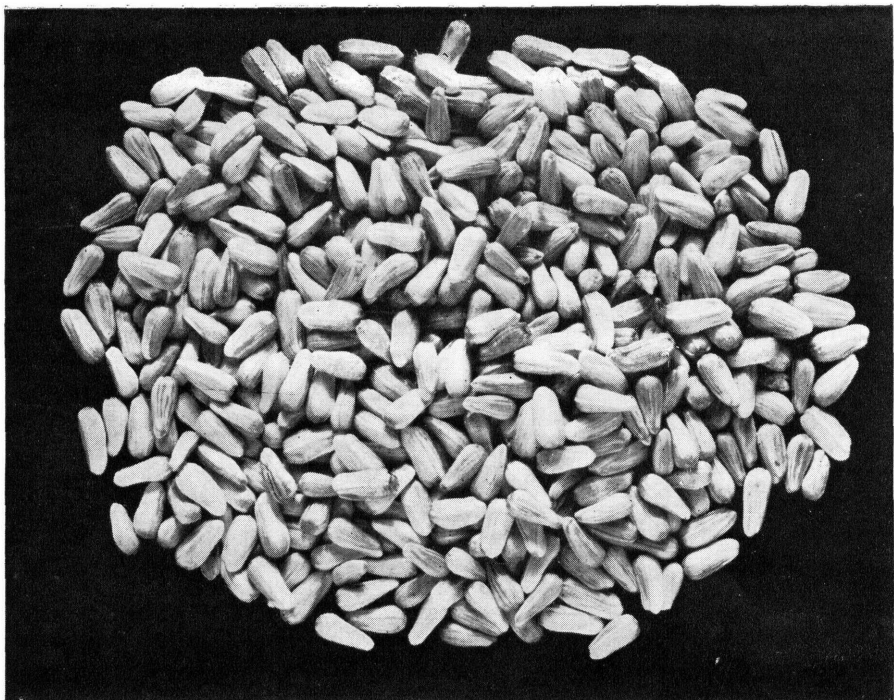
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<sup>2</sup> 2.8 percent ethyl mercury 2,3-dihydroxy propyl mercaptide; and 0.6 percent ethyl mercury acetate.

<sup>3</sup> 2.2 percent methyl mercury dicyan diamide.

<sup>4</sup> Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guaranty or warranty of the product named and does not signify that this product is approved to the exclusion of other comparable products.





BN-6697

Safflower seed, natural size.

the dosage recommended for flax seed.

Where wireworms are a problem, treat safflower seed with a recommended insecticide before planting. Ask your county agricultural agent for current seed treatment recommendations. Seed should be treated at least 24 hours before planting; it may be treated early and stored for several months.

Treated seed should be plainly tagged or labeled as follows:

**Treated seed—Poisonous—Do not use for food, feed, or oil.**

## PLANTING DATES

Planting dates are determined by local conditions—including soil moisture, weeds in the seedbed, and temperatures. Delay planting until

after rain or an irrigation if the top 3 inches of soil is dry. Plant safflower when soil temperature is about 40° F.

Seeds germinate quickly at temperatures near 60°; plants may take 30 days to emerge at soil temperatures below 40° F.

Plant safflower during the fall or early winter in Arizona, in irrigated valleys of southern California, and in other areas where winter temperatures remain above 20° F. Plant it after November 1, so that it will be in the rosette stage when temperatures drop below freezing.

Do not plant safflower in the fall or winter on severely weed-infested land, because weeds may crowd out the safflower.

In the northern Great Plains, early spring planting produces high-

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## Recommended Planting Dates

### REGION:

Arizona:	<i>Planting dates</i>
Safford.....	Nov. 1 to Dec. 1
Salt River Valley.....	Dec. 1 to Jan. 1
Yuma.....	Dec. 15 to Jan. 15
Elsewhere.....	Nov. 1 to Jan. 15
New Mexico.....	Nov. 10 to Feb. 15
California:	
Imperial, Palo Verde, and Lower San Joaquin Valleys.....	Nov. 10 to Feb. 15
Sacramento and Upper San Joaquin Valleys.....	Feb. 1 to Mar. 1
Northern areas.....	Feb. 1 to Apr. 1
Western Nebraska.....	Mar. 25 to May 10
Washington:	
Southwestern area.....	Apr. 1 to mid-April
Palouse area.....	Late April
Montana, North Dakota, and South Dakota.....	Apr. 10 to May 10
Idaho and Wyoming.....	Apr. 15 to May 1

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est yields. Plant safflower as early as possible after frost is out of the ground and temperatures below 20° F. are unlikely.

In California experiments, summer-planted safflower produced low yields.

## CULTURAL PRACTICES

### Soil Preparation

Prepare a seedbed that is free of weed seeds and seeds of other crops. Break up large clods and work the soil into a firm surface. Soil should be moist at least 1 inch below the surface.

For spring-planted safflower, plow in the fall as soon as possible after harvesting the previous crop, unless winter erosion is expected.

For safflower following fallow, leave enough stubble on the soil

during the winter to prevent soil blowing.

Allow weed seeds, volunteer wheat, and other small grains to germinate. Immediately before planting safflower, destroy weeds and grain by using a plow, disk, duckfoot cultivator, rodweeder, or one-way. Till the soil a second time if necessary.

### Fertilization

Where nitrogen increases other crop yields, it will benefit safflower. Nitrogen is not needed on most soils following alfalfa, sweet clover, or fallow.

Natural fertility of the land and available moisture determine the amount of commercial fertilizer needed. Use 20 to 40 pounds of nitrogen per acre on land of average fertility; work it into the seedbed.

If more than 1½ tons of straw were returned by the previous crop, use about 50 pounds of nitrogen per acre.

Where safflower is grown under intensive irrigation, use 60 pounds of nitrogen per acre at planting time and 40 to 50 pounds before budding.

Apply phosphate if previous crops grown on the soil responded to it.

## Planting

Safflower may be planted by solid drilling, in cultivated rows, or by broadcasting.

Solid drilling, which is used most often in dryland areas, produces heavy stands. In some areas, seed from solid-drilled safflower contains 1 to 2 percent more oil than rowplanted seed. Safflower usually is planted in cultivated rows when it is grown under irrigation or when weeds are a problem. Broadcasting seldom is used.

Plant safflower with a grain drill. Seed runs through the drill faster than barley; set the drill as you would for 20 pounds of barley to plant 30 pounds of safflower per acre. Drills set for 3 pecks of wheat deliver about 30 pounds of safflower per acre.

Plant seed 1 to 2 inches deep into moisture for best results. Seedlings will emerge from a depth of 4 inches in moist soil if a crust does not form on the soil surface.

**SOLID DRILLING.**—Drill rows 6 to 12 inches apart for solid stands. Seeding rates vary from 15 to 40 pounds of seed per acre on dryland areas. On irrigated and subirrigated land, sow solid-drilled safflower at the rate of 20 to 50 pounds

of seed per acre. Stands of 3 to 4 plants per square foot are best. In stands with less than 2 plants per square foot, weeds may overshadow safflower; in stands with more than 6 plants per square foot, overcrowding will reduce yields.

**ROW PLANTING.**—Plant cultivated rows at the rate of 8 to 20 pounds per acre for dryland areas and 20 to 25 pounds per acre for irrigated and subirrigated areas. A cultivated row should contain 5 to 12 plants per foot. Place rows 18 to 24 inches apart to allow for cultivation and irrigation. Plant furrow-irrigated safflower in rows 20 to 30 inches apart or on beds 40 inches from center to center with 2 rows set 14 inches apart on each bed.

**BROADCASTING.**—Broadcasting is not recommended for late planting when soil has begun to dry. Seed should be broadcast on moist soil. Use 30 to 60 pounds of seed per acre on irrigated land or 25 to 50 pounds of seed per acre on dryland. After seeding, harrow to cover safflower with 2 to 4 inches of soil.

## Cultivation and Weed Control

During slow early growth, safflower may be crowded out by weeds. Control weeds by crop rotation and by cultivation. Chemical weed killers do not work well in safflower, and hand hoeing is not practical.

Weeds may come up before safflower does if rainfall occurs soon after planting. Most small weeds in solid-drilled stands can be destroyed by shallow harrowing.

Work the field with a harrow, rotary hoe, or finger weeder diagonally or crosswise to the direction

of seeded rows. Set teeth fairly straight and weight the harrow.

Harrow seedbeds for the first time before plants emerge, or when only a few seedlings have emerged. Do not harrow after complete emergence until plants are about 3 inches high; at this time harrowing may cover plants and reduce stands.

If weeds remain a problem, harrow again when plants are 3 to 6 inches high. At this stage, safflower begins rapid growth and competes well with small weeds in solid-drilled fields so that hoeing usually is not necessary.

Cultivate row-planted safflower 2 or 3 times, in the same manner as



BN-6695

Safflower plant showing leaves, branching habit, and flower heads.



for other row crops. The final cultivation may be made just before flowering.

Harrowing furrow-planted safflower before emergence is not recommended because it may bury seed too deep.

None of the chemical weed killers tested in 1957 were satisfactory for use on safflower. The crop can be severely damaged by 2,4-D, other hormone-type herbicides, and dinitro selectives.

New herbicides are being developed rapidly. Ask your county agent or write your State agricultural experiment station for latest information on weed control in safflower.

## IRRIGATION

Irrigation increases safflower yields when soil moisture is low. Soil moisture, rain, and temperatures affect the number of irrigations needed.

If rainfall is inadequate during the growing season, 2 to 5 irrigations are needed for maximum yields.

Avoid overirrigation; safflower is sensitive to too much water. The crop may be killed if water stands in a field for more than a few hours.

### Irrigation Dates

Although plants need adequate moisture from planting through flowering, water is most important at the budding stage.

To obtain maximum yields in the northern Great Plains, irrigate in late June, soon after buds start to form; in mid-July, after flowering; and in early August, before flower-

ing ends. In California, irrigate fall-planted safflower 3 to 5 times, as needed.

Safflower needs preirrigation in areas where small grains need preirrigation. Usually, fall-planted safflower is preirrigated.

Do not irrigate from the time plants emerge until stems develop. During this period, irrigation will benefit weeds which compete with safflower.

If you plan to irrigate only once, apply water when plants begin to bud. Use a fairly heavy irrigation.

With two irrigations, apply water for the first time 4 or 5 weeks after safflower begins to grow erect. Irrigate again 7 to 10 days after flowering.

If needed, apply additional light irrigations at 2-week intervals until the end of flowering.

Apply an irrigation immediately if leaves begin to fire or wilt. Firing may decrease yields.

### Types of Irrigation

Water may be applied in furrows or by flooding. Occasionally, overhead sprinklers are used.

Use furrow irrigation for row-planted safflower. Make furrows deep enough to avoid flooding; place them 20 to 24 inches apart. Prepare furrows 7 to 10 days after safflower begins branching.

Use flood irrigation for solid-planted safflower. Avoid ponding at lower ends of the checks, if possible.

Overhead sprinklers may be used until safflower reaches the bud stage. Later use of sprinklers may result in disease development.

## SUBIRRIGATION

Subirrigation has many advantages when used to grow safflower. Previous irrigations leave enough soil moisture to bring safflower to the flowering stage without additional water.

Subirrigation reduces the danger of flooding and root rot.

## HARVESTING

Safflower matures in about 120 days under favorable conditions. Cool weather, rain, or early frost may delay maturity.

Combines with either tooth or bar cylinders may be used. The crop is easy to harvest with a combine because the seed does not shatter readily. It is difficult to harvest safflower without a combine because of the spines.

Safflower is ready for harvest when blooms disappear and seed is hard and dry. Test for maturity by squeezing several of the most recently developed heads. If the seed separates easily, it can be threshed. Green or wet seed is hard to thresh and will not store well if it has more than 8 percent of moisture.

The crop can be combined as soon as it is mature. It may be left in the field for as long as 30 days with little loss at harvest. Light rains or frost after maturity will not harm it greatly.

If seed will be used for planting, harvest as soon as it is mature.

Use a preharvest contact weed-killer when late-maturing or green weeds make direct combining impossible. For each acre to be sprayed, use 1 quart of a DNBT



Harvesting safflower with a combine.

BN-6690-X

herbicide<sup>5</sup> mixed with 15 gallons of diesel oil.

Safflower may be swathed and allowed to dry before it is threshed with a combine and pickup attachment.

Safflower cannot be threshed as fast as barley or wheat. Adjust the speed of the combine so that few seeds are cracked in threshing. Remove concave teeth or reduce to 1 or 2 rows. Teeth should just begin to mesh with cylinder teeth. Adjust rub- or bar-type cylinders to ½-inch clearance between concaves and cylinder or sufficiently close to thresh all the seed without damage.

Safflower may shatter if the reel slats strike ripe seed heads directly. Modify the reel by attaching 4- to 6-inch strips of flexible belting to the slats. Raise the reel so that only the top of the belting hits the plants. Equalize speed of reel with forward speed of the combine. If heads catch on slats, plug the space between the reel arms with plywood, canvas, or mesh wire screen.

Lower the cutter bar to cut fairly long stalks. Short stems may plug rattle rakes.

Set shaker screens slightly faster than usual. Adjust wind speed to remove the light seed but no filled seed. Enough wind is needed to blow away the fuzz from the seed. Screen the front of the radiator on the combine motor to prevent this fuzz from clogging the radiator.

Adjust the sieve so that it will remove small sticks, leaves, and stems.

Lodged plants can be combined by using a pickup guard.

<sup>5</sup> 4,6-Dinitro ortho secondary butylphenol.

Handle threshed safflower seed in bulk, if possible, because seed sacks pick up spines from the fields.

## INSECTS

Insects have caused only minor damage to the total safflower crop. However, they may cause substantial loss in individual fields.

For current recommendations on controlling insects that attack safflower, ask your county agricultural agent or write to your State Agricultural Experiment Station or to the U. S. Department of Agriculture, Washington 25, D. C.

Damage by lygus bugs can cause safflower heads to discolor, develop rot, or fail to form. Damage is most severe in late-sown fields. Control lygus bugs by spraying once or twice with DDT at the time buds are developing.

Wireworms may cause poor stands. Control these insects by treating seed with a recommended insecticide before planting.

Aphids, leafhoppers, and larvae of the sunflower moth cause occasional damage to safflower.

Grasshoppers may feed on safflower after small grains are harvested. Damage usually is limited to margins of fields. Control of grasshoppers has been obtained with aldrin, chlordane, dieldrin, heptachlor, and toxaphene.

**CAUTION:** Do not let dairy cattle or animals being finished for slaughter eat plants treated with aldrin, dieldrin, DDT, chlordane, or toxaphene. If necessary, safflower may safely be used as livestock feed 7 days after it is treated with 4 ounces of heptachlor per acre.

## DISEASES

In the United States, the most prevalent diseases of safflower are rust,<sup>6</sup> root rot,<sup>7</sup> leaf spot,<sup>8</sup> and bud rot. The amount of damage they cause depends on weather conditions, cultural practices, and the safflower variety.

Under certain conditions, diseases make production of present safflower varieties unprofitable. For example, phytophthora root rot has destroyed entire crops grown under flood irrigation in California. To avoid such losses, flood irrigation seldom is used in California; most of the acreage is grown by subirrigated or dryland methods.

### Rust

Rust may occur in any area in the United States where safflower is adapted. It is most prevalent in the northern Great Plains and in the northern San Joaquin and Sacramento Valleys. High humidity from atmospheric conditions or irrigation is necessary for rust to develop profusely. The disease seldom is a problem on dry land.

Rust may cause serious stand loss when it develops on the roots, crowns, and stems of young plants from either seed- or soil-borne spores. If rust becomes severe, leaf pustules resulting from wind-blown spores may cause high losses in safflower yields.

Seed treatment with a volatile mercury fungicide will give good—but not perfect—control of seed-borne spores. Crop rotation is

recommended for control of soil-borne spores. Winter flooding of river-bottom land in California sometimes has given adequate control of soil-borne spores. Control of leaf pustules is not practical.

No varieties resistant to all races of rust were available in 1958.

Use rust-free seed, if available, for new areas of production.

Late-planted fields usually are affected less than early-planted fields.

### Root Rot

Root rot may destroy entire plantings of safflower.

The soil-borne fungus that causes root rot is widely distributed in the western United States. Root rot is common in the Southwest, where high temperature and high soil moisture favor the development of the disease. Root rot is most severe on surface-irrigated land; it seldom affects subirrigated or dryland plantings.

Although it may occur at any time, root rot usually develops after the first irrigation. Affected plants dry up quickly and turn light green. Roots and lower stems rot and become dark green or black.

Do not plant safflower on land with poor water penetration or drainage, because root rot readily attacks such plantings. Avoid long irrigation runs, but irrigate often enough to prevent damage from lack of water or from firing of lower leaves.

When possible, grow safflower on beds under furrow irrigation instead of flood irrigation. Furrow irrigation reduces the danger of standing water and damage by root rot.

<sup>6</sup> *Puccinia carthami* Corda.

<sup>7</sup> *Phytophthora drechsleri* Tucker.

<sup>8</sup> *Alternaria carthami*.



Varieties differ in resistance to root rot. Both N-10 and Pacific 1 are highly susceptible. Resistant varieties should be available for production in the future.

### Leaf Spot

Leaf spot reduces yield and oil content of safflower.

In irrigated fields in Nebraska, leaf spot has caused considerable damage. It may occur whenever and wherever frequent dews and showers fall during the middle and latter part of the growing season.

Leaf-spot fungus may be seed-borne. The disease produces large, brown, irregular spots on leaves and flower bracts. It discolors seed and causes seed rot and damping-off.

Seed treatment with a volatile mercury fungicide will give excellent control of the seed rot and damping-off phases of the disease. Available safflower varieties have some tolerance to leaf spot. This disease is one factor which limits production to areas having dry atmospheric conditions.

### Bud Rot

Bud rot may affect most of the heads in a field and reduce yields. It is a problem in areas with high humidity or plentiful rainfall. Bud rot occurs in the northern Great Plains and in the foggy coastal areas of California.

Bud rot often is associated with insect injury to the buds. Various fungi—mostly *Alternaria* or *Botrytis* spp.—invade injured buds, causing them to discolor, shrivel, or fail to develop.

### Other Diseases

Verticillium wilt <sup>9</sup> and Fusarium root rot <sup>10</sup> cause minor damage in the present areas of production. These diseases may attack irrigated safflower in areas where they attack other crops.

Neither Verticillium wilt nor Fusarium root rot cause serious damage on safflower grown under dry-land conditions.

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<sup>9</sup> *Verticillium albo-atrum*.

<sup>10</sup> *Fusarium solani*.